REMARKS

Reconsideration of the above-mentioned application is hereby requested in view of the above amendments and remarks which follow. Applicants appreciate the Examiner's thorough consideration of the application.

The Examiner objected to the application for failing to provide drawings. Applicants wish to remind the Examiner that this application was a national filing under 35 USC §371. All of the drawings were filed as part of the national entry. Moreover, this application has already been published as US 2006/0174769 and the drawings form part of the published US application. As a courtesy, a copy of the publication is enclosed for the Examiner reference, noting that these drawings already form a part of the present application.

In response to the Examiner's rejection of claims 18 to 22 under 35 USC §112, second paragraph, amended claims 18 to 22 are now provided, which have been amended to specifically recite process features. Applicants believe that these claims are now in proper format and respectfully request the removal of the rejection.

The Examiner has now rejected claims 11 and 12 under 35 USC §103 (a) as being unpatentable over US 5,472,719 "Favre" in view of US 6,752,070 "Lin". The Applicant respectfully traverses the Examiner's rejection, and it is respectfully submitted that claims 11 and 12 are non-obvious over the cited documents.

It is again pointed out that Favre describes two separate embodiments of a capsule carrier (9), the first embodiment, as shown e.g. in figures 3 to 5, col. 5, lines 40 to 58, (i.e. the section referred to by the Examiner in the examination report) in which the lower wall of the capsule carrier is a filtering wall (10) with a plurality of sharp perforating tips (13) and a plurality of outlet orifices (12). The second, alternative embodiment, as described col. 6, line 64, to col. 7, line 31, with reference to figures 6, 7, 8 and 8a, is designed for extracting beverages from capsules containing a soluble or liquid substance, for which a filter for retaining solid substance in the capsule is therefore not necessary. In this second

embodiment, the capsule carrier has instead of a perforating filtering wall (10) a perforating lower wall with a single centrally located sharp tip (22) or sharp projection with an upper cutting edge (27), and a single central outlet opening (23, 24) in the single central perforating member (22/27). In other words, Favre describes a capsule carrier having a perforating lower wall either in the form of a filter wall (10) with a plurality of perforating projections and outflow orifices, or a single central perforating sharp tip/projection (22/27) with a single central outflow orifice. The capsule carrier (9) of Favre does not have, in addition, to a filtering wall, with a plurality of perforating projections and outflow orifices, a separate bottom wall, whereby there is a lower cavity portion between the filtering and bottom wall, and which bottom wall comprises outflow channels surrounded by lips which protrude upwards with respect to the lowest point of the lower cavity portion.

Lin describes an apparatus for the preparation of filter coffee. In the apparatus described by Lin, hot water brought from a hot water reservoir flows into a filter cup 6 containing coffee powder. The made coffee then flows through meshed openings (61) in the bottom of the filter cup 6 and through a central hole (52) in a silicone rubber member (5), whereby the coffee then flows into a well section (31), and overflows from the well into raised grooves (32) once the well is full of coffee, and then flows out of the hollow leg members (33) into two cups (see Lin, col. 2, lines 24 to 31 and figure 4). Contrary to the examiner's assertion, the aim of the apparatus described by Lin is, *inter alia*, to provide a quick flow of coffee into the coffee cup, (see col. 2, lines 34 to 37), and the apparatus of Lin does not operate to "*delay the rate at which beverage leaves the device*" as asserted by the examiner.

Further, it is clearly seen that in the apparatus of Lin, there is no disclosure whatsoever of upwards protruding lips which have the openings in the form of slots or of holes configured specifically to enable the liquid to flow out from a capsule carrier at the lowest point, as required by claim 11 as now amended. In the device of Lin, the grooves (32) are raised with respect to the lowest point of the well (31) (see figures 3 and 4), and there is no possibility of outflow of liquid at the lowest point, as liquid must leave the well via the

raised channels (32), leading to the hollow leg outflow orifices (33). This can clearly be seen from figure 4, in line with the description col. 2, lines 27 to 31.

Finally, it must be pointed out that the device of Lin is designed for the preparation of filter coffee, whereby made coffee will drip through the central orifice (52), below the filter cup into the well (31). Contrary, to the apparatus of the present invention, the coffee in Lin is not extracted under pressure, and the device of the present invention has a completely different function. In the device of the present invention, liquid under pressure pours into the cavity (7b) between the intermediate bottom wall (6) and the lower bottom wall (12). The liquid coffee extracted under pressure from the capsule has a layer of froth, which froth is not present in filter-type coffee prepared simply by pouring water over coffee grinds in a cup, as in Lin. The upwardly protruding lips (14) surrounding the outflow channel (13) in the apparatus of the present invention, advantageously make possible for a portion of this froth floating on the surface of the liquid coffee in the cavity portion (7b) to enter the outflow channel and empty out of the apparatus at the same time as liquid without froth, which enters the outflow channel through the slots or holes in the upwardly protruding lips, extending to the lowest point of the lower cavity portion. This system advantageously makes it possible to retain a larger amount of froth than in prior art systems and also, at the same time, allows a full evacuation of the liquid from the capsule carrier (see, for instance page 5 paragraph 1 of the English translation of the present application text, and the figures).

The Examiner again rejects claims 1, 2, 4, 5, 7, 18-24, 26 and 27 under 35 USC §103(a) as being unpatentable over US 6,182,554 "Beaulieu" in view of US 5,762,987 "Fond '987". The Applicant cannot agree with the Examiner's analysis of the prior art, and the rejection is respectfully traversed.

With respect to the Examiner's comments it is first highlighted that in the device described in Beaulieu the cartridge upper membrane (52) is pierced by a single downwardly projecting apertured probe (126) to establish a flow inlet for providing liquid to the interior of the cartridge (see Fig. 6b and 2a, col. 4, lines 43 to 47). Contrary to the Examiner's assertion, in Beaulieu the water for extraction of the coffee is injected directly into the capsule through

the aperture probe and **not** onto the flexible membrane as required by pending independent claim 4. The use of an apertured probe, such as in Beaulieu, which injects hot water directly into the interior of the capsule would make it impossible to achieve the pressure auto-regulation and automatic adjustment of the compression of the product in the capsule provided by the method of the present invention.

It is highlighted that Beaulieu specifically requires the combination taught therein of a flat perforating head having a single central apertured probe for piercing the capsule top flexible membrane in order to fulfil the desired function of the device of automatic ejection of the spent beverage capsule. Accordingly, it is clear that the injection head taught by Fond '987 with its plurality of perforating members is incompatible with the device and teaching of Beaulieu. The plurality of perforating points of Fond would have the effect of increasing adherence of the flexible top membrane of the cartridge to the perforating head at the numerous injection points, and accordingly, the injection head taught by Fond '987 with its plurality of perforating members would not allow to achieve to object taught by Beaulieu of facilitating automatic dislodging of the capsule from the capsule carrier. Accordingly, the skilled person on reading Beaulieu, would be specifically taught away from attempting to use the perforating head of Fond '987, with its plurality of perforating members.

Nevertheless, even though it is considered that the Examiner's rejection of the claims based on Beaulieu in view of Fond 987 is traversed by the comments outlined above, independent claim 4 is now amended to incorporate the features of previous claims 5 and 6, and claims 1 to 3 are cancelled without prejudice, in order to expedite the allowance of the above-referenced application. It is respectfully submitted that none of the cited prior art documents make any disclosure or suggestion whatsoever of the feature of an injection head having a perforating surface having a shape which is convex when viewed from the outside, as required by amended claim 4.

The Examiner has rejected, in this second non-final Office Action, the examined claims 3 and 6 under 35 USC §103 (a) as being unpatentable over Beaulieu in view of Fond '987, and further in view of US 7,024,985 "Park". In the claims as now amended, the

objected claim 3 has been cancelled, without prejudice, and the features of previous claim 6 have now been incorporated into the amended claim 4. Accordingly, the Examiner's objections to examined claims 3 and 6 are now addressed, making reference to amended claim 4.

At the outset, it may be mentioned that the Examiner's objection is drawn from a piecemeal of isolated features of incompatible components drawn from incompatible prior art documents directed to devices having completely different functions and modes of operation. The Examiner's objection appears to be completely based on unallowable hindsight. The Examiner has tried to combine a device for the extraction of coffee from cartridges, in which there is a capsule holder, a capsule with an upper membrane, and an injection head (40) having a flat surface and a single apertured probe (126) for piercing the capsule membrane and establishing a flow inlet for providing liquid to the interior of the cartridge and which apparatus is aimed at allowing automatic ejection of spent capsule from the device (Beaulieu & al.); with a device for the extraction of coffee from flexible sachets having a concave perforating head, in which the perforating head and a bottom sachet holder member have complementary concave shapes in order to ensure the shape of a flexible sachet during extraction, and to confine the substance within the sachet within the cavity, and having in one embodiment a plurality of perforating members on the concave perforating head to pierce the sachet (Fond '987); with finally an apparatus for the extraction of coffee from loose coffee grinds, in which opposed piston heads hold the coffee grinds in place in a container section, whilst water is flowed though an entry channel in one piston head, for preparing the coffee. Quite clearly the Examiner's picking of isolated features, in a piecemeal manner, from these unrelated documents is without any founding.

In Park, there is described a device for the preparation of coffee from loose coffee grinds. In the device of Park there is described an upper-piston unit (130) with a hot water path therethrough (134) and a plurality of hot water discharge paths (136) covered by a filter (137). The upper piston unit is inserted into a cylinder (151) unit into which hot water is introduced through the water flowpath of the upper piston (130), whereby the hot water flows out of the water discharge paths (136) and the filter (137) into a space in the cylinder (151)

between the bottom of the upper piston unit (130) and the top of a lower piston unit (140) provided with a second filter (143), to prevent passage of coffee grinds through the piston, and a coffee discharge trough (142) and pipe (153) (see col. 6, line 44 to col. 7, line 28). In operation, the upper piston unit (130) presses the coffee grinds disposed on the top surface of the lower piston (140), whilst the water is discharged through the flowpath (134) into the cavity, in order to squeeze the made coffee out of the coffee grain/water mixture for discharge through the discharge trough (142). Accordingly, in Park the slightly convex configuration of the upper and lower pistons heads, is designed simply to enable the squeezing of the coffee grain/water mixture held between them, such that the made liquid coffee can be pushed out to the outside of apparatus, via the discharge trough (142), (see col. 8 lines 4 to 10).

So it is seen that the apparatus of Park, for the preparation of coffee from loose coffee grinds, functions by squeezing a mixture of coffee grinds and water, between the piston heads in order to extract the coffee. This is a completely different mode of functioning compared to the apparatus of the present invention which is designed for the preparation of liquid beverages from closed capsules, in which the extraction of the beverage is achieved by the injection of water under high pressure into the capsule.

The apparatus of the present invention, and that of Beaulieu, work on the principle of extraction of coffee from closed rigid capsule, and for that of Fond '987 from flexible sachets, by the actions of water injected under high pressure through an injection head with perforating members. In such systems, there is no need to squeeze the mixture of coffee grinds/water in order to extract the coffee, since the made coffee is extracted from the coffee grinds in the capsule solely by the water under high pressure, and indeed this would be undesirable as it would go against the principles of high-pressure extraction from capsules, which make it possible to provide the beneficial features of a real espresso coffee, with respect to extraction and froth formation etc. Accordingly, the skilled person, on reading Beaulieu & Fond '987 would have absolutely no reason whatsoever to contemplate the piston head, taught in Park. Further, such a piston head would be incompatible with the teaching of the documents Beaulieu and Fond '987.

It is again highlighted that the claimed configuration of a convex perforating surface of the injection head is not disclosed in any of the cited documents and advantageously enables to control well the pressure of the perforating points against the flexible membrane of the capsule, and thereby to control the perforation of the membrane, and the size of the smooth holes perforated by the perforating points, in order to control the auto-regulation.

The Examiner now rejects claims 8 and 9 under 35 USC §103 (a) as unpatentable over US 5,398, 595 "Fond '595" in view of US 5,598,764 "Bambi". The Applicant cannot agree with the Examiner's analysis of the cited documents, and this objection is respectfully traversed.

Fond '595 describes a device for the preparation of coffee by extraction under pressure from rigid capsules, having a upper membrane. In the device of Fond '595 the upper membrane of the cartridge is torn open by projecting elements in the form of frusto-conical points (that is to say a cone of which the top is cut forming a crest, or by small foils or crosses cut slightly in a crest (see Fond '595 col. 5, lines 17 to 21) and in Fond & al. there is no description of the "perforating spikes having a smooth tapered shape without sharp edges and an average cone angle less than 60°", in order to form smooth holes across the capsule upper membrane, as required by claim 8. In Fond '595 the aim is simply to enable water to be introduced into the capsule as easily as possible (see col. 2, line 56 to col. 3, line 8). In this regard, Fond '595 teaches specifically the tearing of the upper membrane by the perforating elements. In fact in Fond '595 is it further described that the protruding elements may be orientated at an angle so as to increase the surface of the tear produced on the capsule membrane. Fond '595 considers even the use of capsules which are open, (col. 4, line 51).

It is noted that in the process taught by Fond '595, the use of perforating elements of the perforating member in the form of frustum of a cone, foils or crosses causes tearing of the upper membrane, and accordingly, when water is injected onto this torn membrane, the membrane will be first ripped open and water will flow freely into the capsule. Accordingly, using the apparatus described in Fond '595 which will cause tearing of the open membrane of the capsule, is it not possible for the ripped membrane to exert any pressure, and accordingly

the device of Fond '595 does not provide any of the advantageous effects of the apparatus of the present invention as claimed in claims 8 and 9, whereby the injection head having perforating spikes having a smooth tapered shape without sharp edges and an average cone angle less than 60° permits the perforation of a plurality of smooth holes distributed across the capsule membrane, such that the intact flexible membrane may exert a pressure on the product in the capsule, preventing the formation of preferential flow channels and providing improved properties of wetting of the product, complete extraction, and froth generation.

Bambi & al. describes a device for preparing coffee from loose coffee powder. In the device of Bambi & al. the component (9H) referenced by the examiner is a "*finely perforated metallic disk 9H which cups slightly downward*". It is noted that the shape of the finally perforated metallic disk 9H is configured specifically in order to leave a chamber (9L) between the top of the disk (9H) and the bottom of a cylindrical element (9E) (see col. 2, lines 40 to 46). In the device of Bambi & al. loose coffee powder (30) is held within a filter (11C) in the shape of a cup.

The device of Bambi has a damping device (15) including a spring (15E) a piston (15D). At the base of the damping device there is a cavity (I) which connects with the chamber (9L) above the perforated disk (9H) through holes in the bottom part of a screw (17). In use of hot water is delivered from the boiler (1) by a pipe (25) to the cavity (I). The increase in water pressure in the cavity (I) pushes up the piston (15D), therefore compressing the spring (15E) (see col. 3, lines 18 to 24). As the water arrives under pressure, the pressure increases in the cavity I, causing compression of the spring (15E). At the same time, since cavity (I) communicates with cavity (9L), the pressure in the chamber (9L), located above the filter cup (11C) containing the coffee, will rise gradually from atmosphere pressure to the pressure value defined by the spring (15E). As explained in Bambi & al., only when the spring (15E) is fully compressed, will the pressure in the chamber (9L), above the perforated disk (9H) rise to the maximum value offered by pump, so that the water passes through the coffee powder, and produces a "cream". The reason for having this damping device (15) which slows down the rate at which the pressure in the chamber (9L) reaches its maximum value for dispensing the coffee, is, according to Bambi & al., in order to enable the water to

soak right through all the coffee contained in the filter (11C) without following preferential routes (see col. 3, lines 24 to 32).

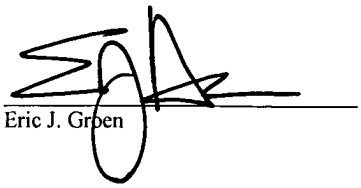
In other words, in the device of Lin & al. the only reason for the slightly downward cupping of the finely perforated metallic disk (9H), is in order to provide a chamber (9L) above the filter, to allow proper functioning of dampening mechanism. This metallic disk 9H does not exert any pressure on the product in the filter cup (11C).

It is respectfully submitted that the feature of claim 8 of an injection head having a perforating surface having a shape which is substantially curved and convex when viewed from the outside is not disclosed or suggested in any of the cited prior art documents, and advantageously enables to control well the pressure of the perforating points against the flexible membrane of the capsule, and thereby to control the perforation of the membrane, and the size of the smooth holes perforated by the perforating points, in order to control the auto-regulation.

For all of the foregoing amendments and remarks, Applicants believe that claims 4, 7-11, and 18-28 are in condition for allowance and respectfully request early passage thereof.

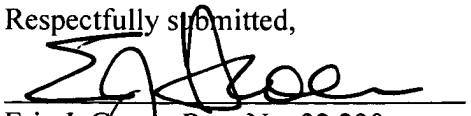
If necessary, Applicants request that this response be considered a request for an extension of time appropriate for the response to be timely filed. Applicants request that any required fees needed beyond those submitted with this response be charged to the account of Baker & Daniels, Deposit Account No. 02-0390 (979078.2).

I hereby certify that this correspondence is being deposited with the U.S. Postal Service as First Class Mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on December 17, 2009.



Eric J. Groen

Respectfully submitted,



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(54) **METHOD FOR PREPARING A BEVERAGE FROM A CAPSULE AND DEVICE THEREFOR**

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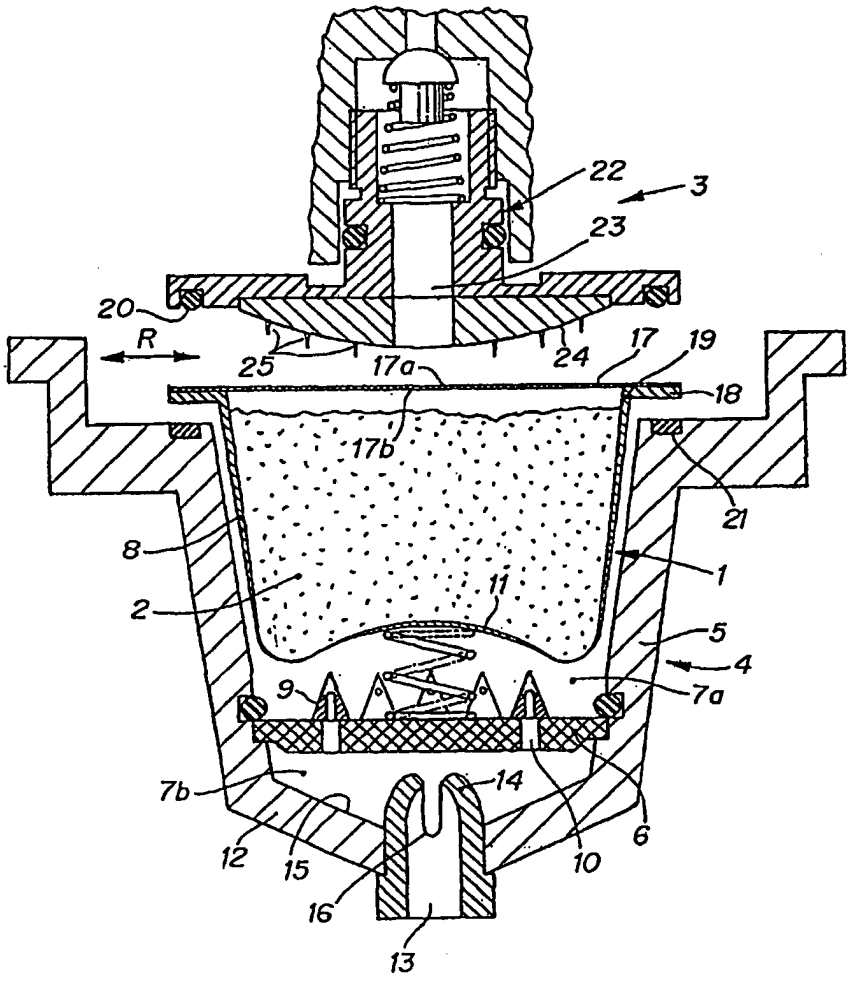
(57) **ABSTRACT**

A method for preparing a beverage or a liquid foodstuff from a capsule containing a product with a substance to be extracted, the capsule having a flexible membrane (**17**) capable of deforming elastically or permanently to a considerable extent, comprising the steps of perforating a plurality of holes (**26**) distributed over the flexible membrane and of injecting water onto the flexible membrane, in such a manner that it deforms in the direction of the product inside the capsule and in that the water penetrates into the capsule via said holes. The size of the holes perforated by the perforating spikes is controlled by the level to which the capsule is filled or by the compactness of the product inside the capsule, so as to influence the hydraulic pressure differential ΔP between the two sides (**17***a*, **17***b*) of the flexible membrane, in such a manner as to achieve an automatic adjustment of the compression of the product contained in the capsule.



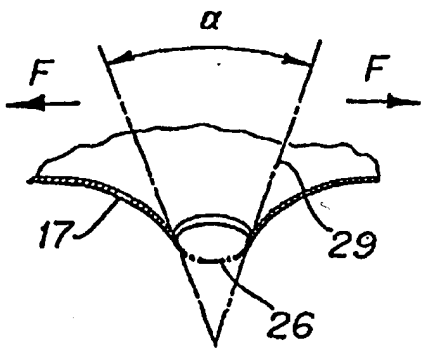

α
F
F
17
29
26

FIG. 2a

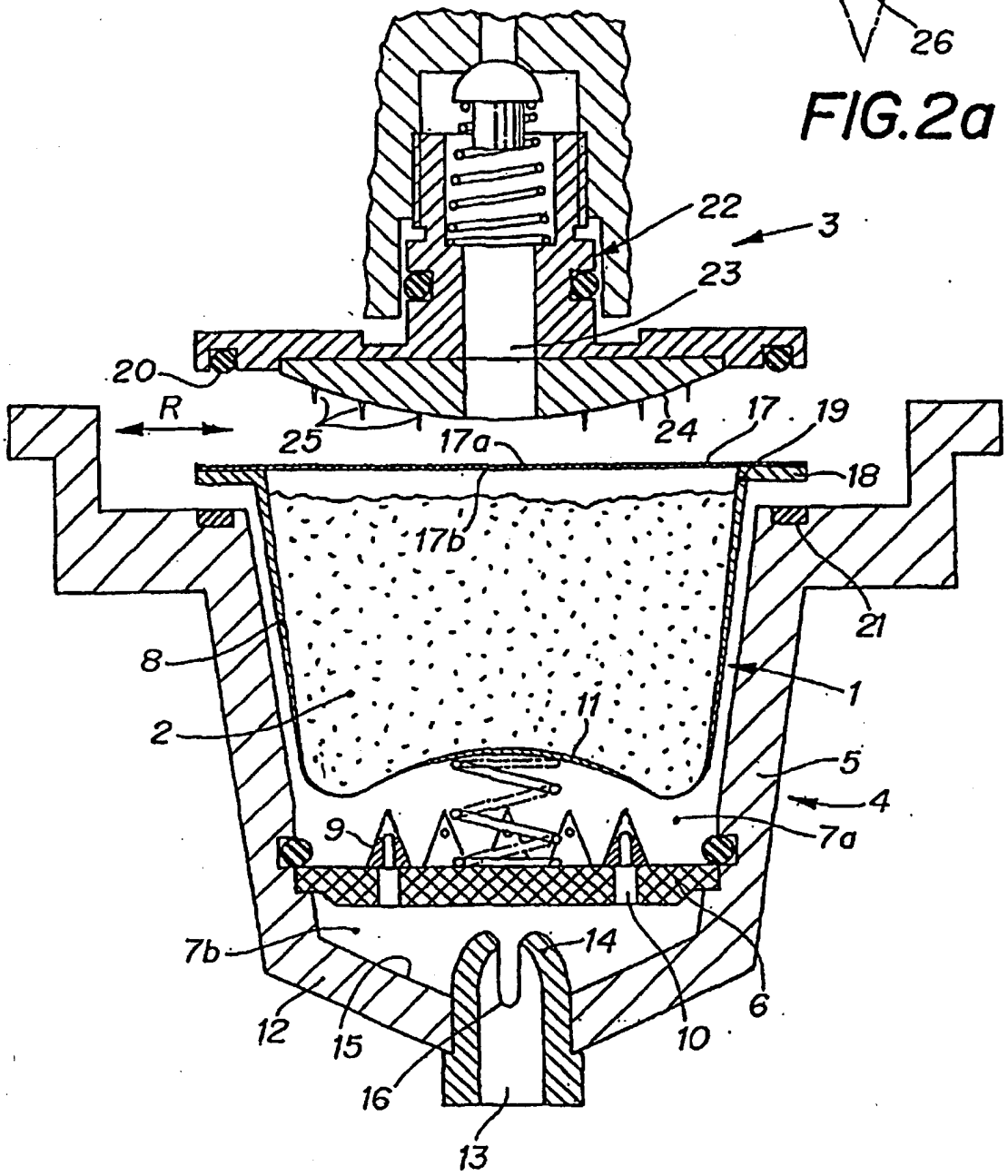

22
3
23
20
R
25
17a
24
17
19
18
17b
21
8
1
2
11
5
4
9
7a
7b
14
12
15
10
6
16
13

FIG. 1

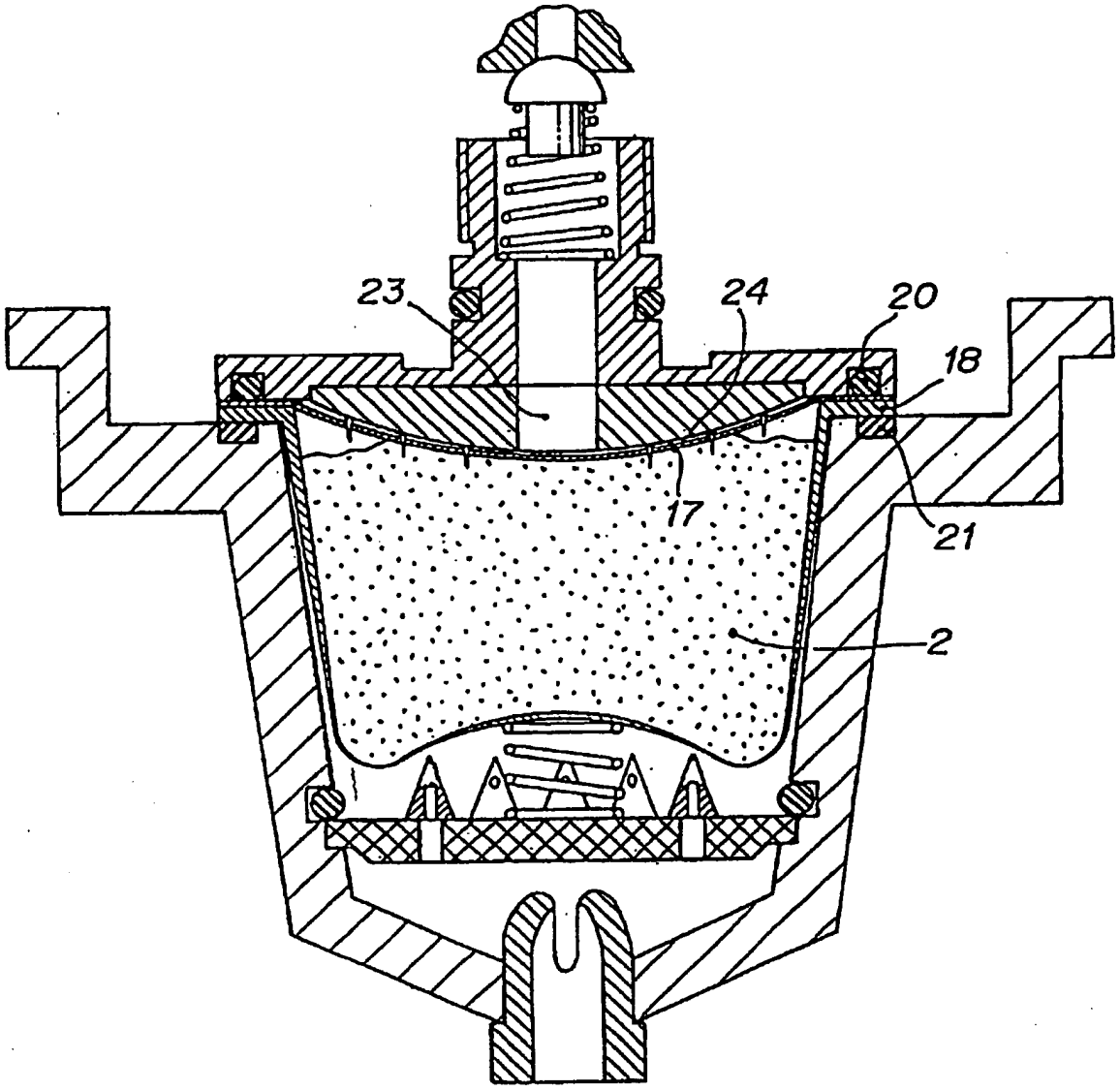


FIG. 2

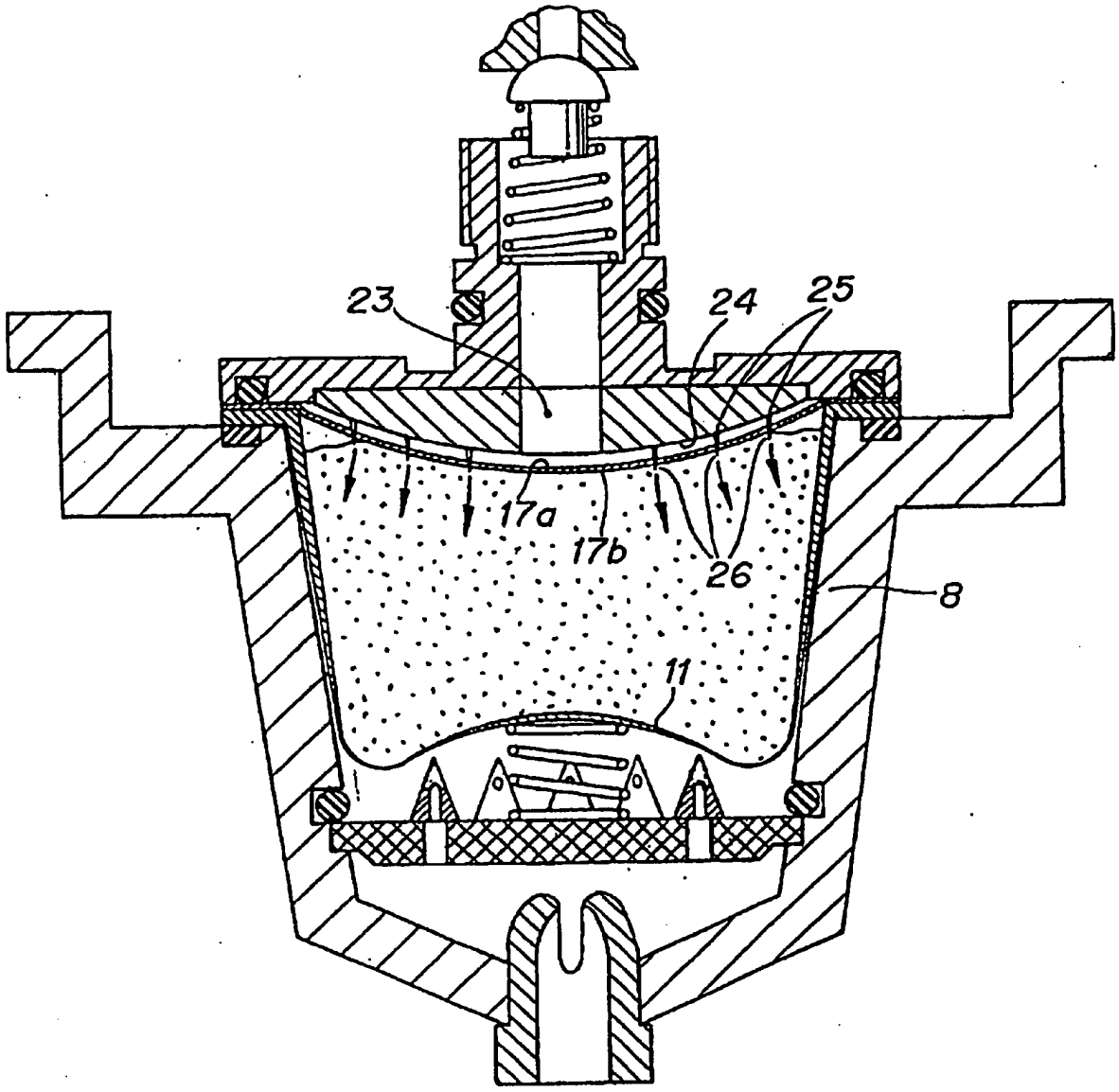


FIG. 3

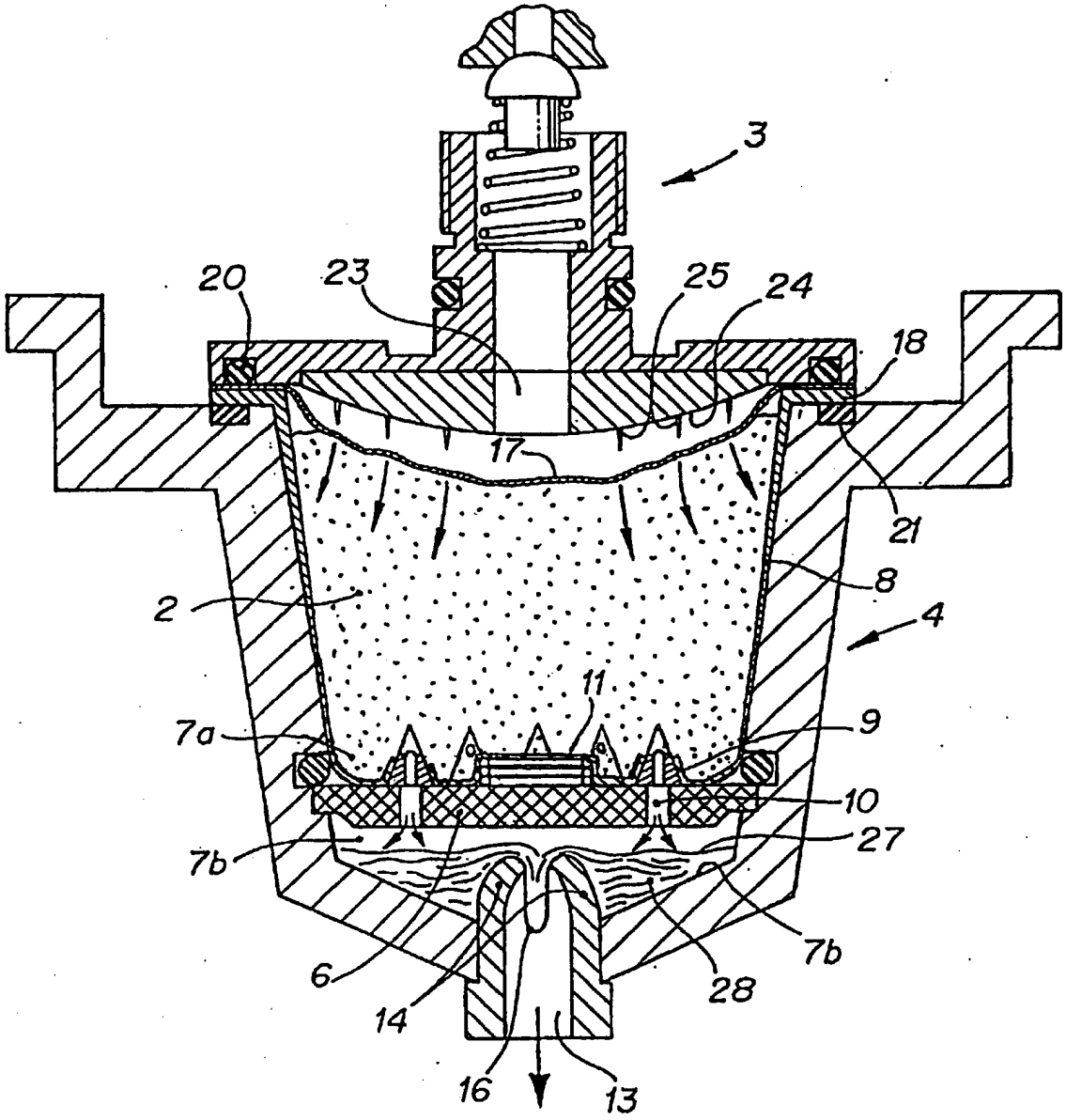


FIG. 4

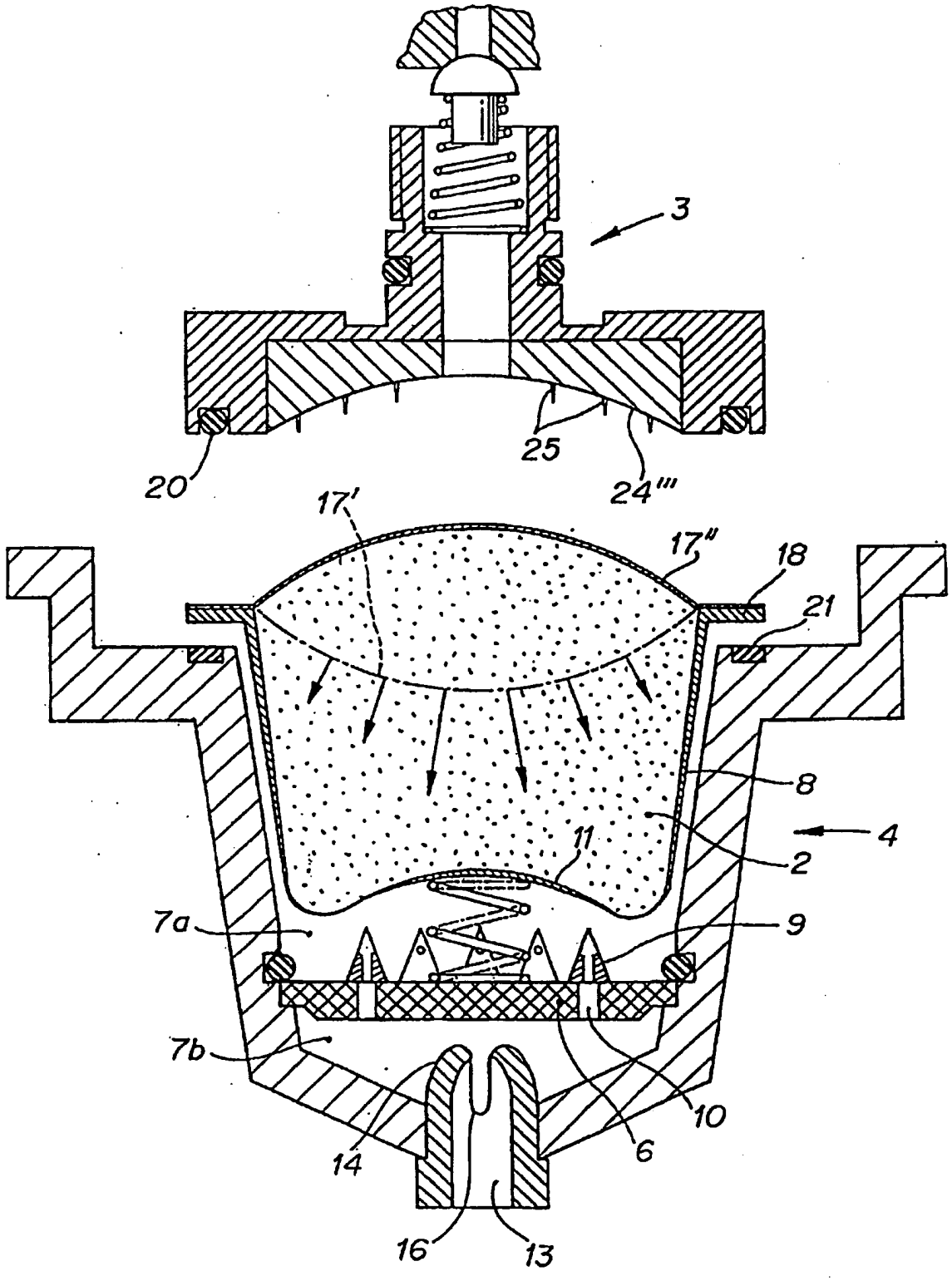


FIG. 5

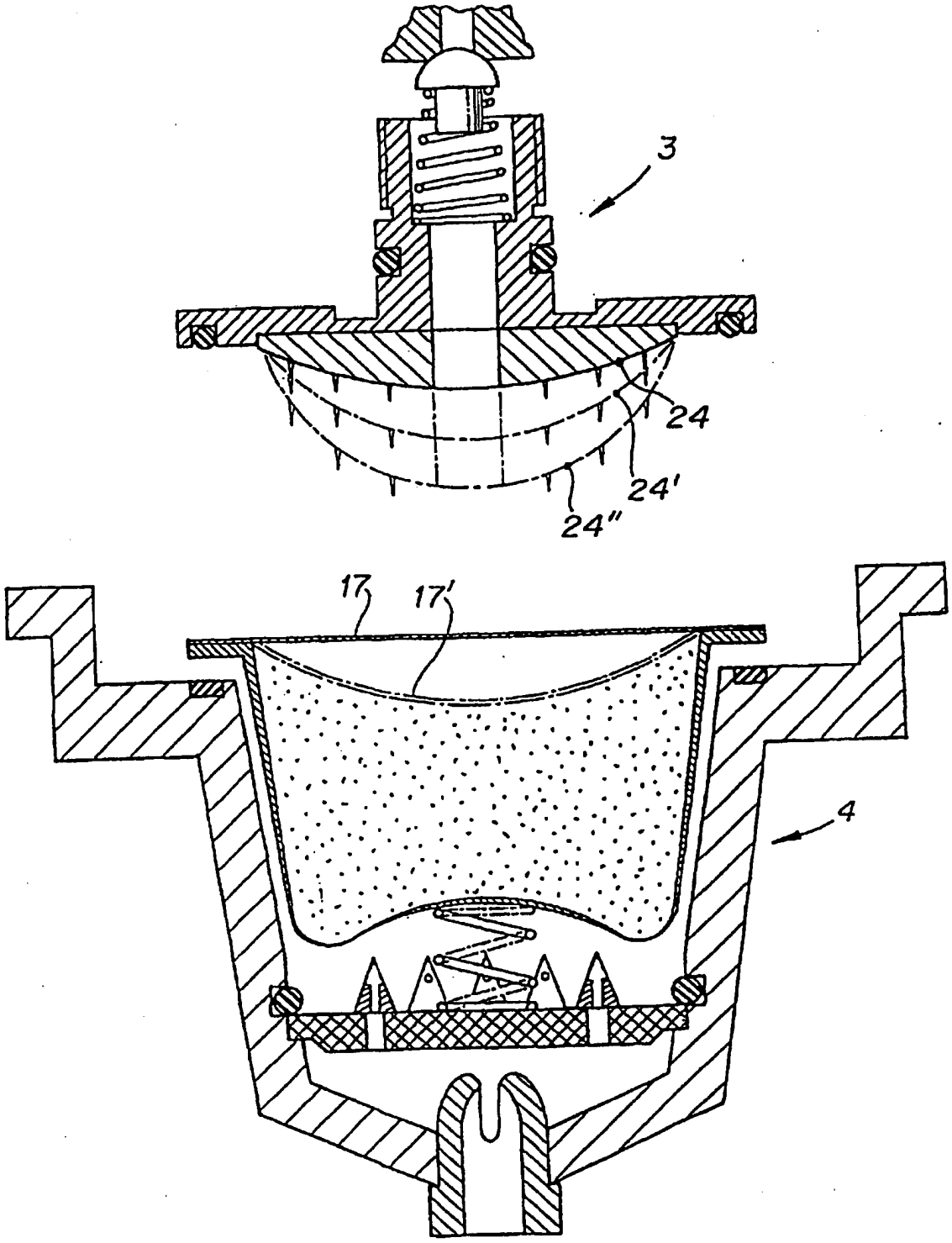


FIG. 6

METHOD FOR PREPARING A BEVERAGE FROM A CAPSULE AND DEVICE THEREFOR

[0001] The present invention relates to a method for preparing a beverage or a liquid foodstuff from a capsule, a capsule containing a substance to be extracted, and a device for carrying out the method

[0002] It is already known how to prepare a beverage from a capsule containing a product to be extracted, for example coffee, such as is described in the international patent application WO 92 07775. The capsule is received inside a capsule carrier or housing of the device, which can be pressed sealingly against an injection head designed as to inject hot water into the capsule. The bottom of the capsule carrier or of the housing is provided with means for perforating the bottom of the capsule, in order to allow coffee or some other extracted beverage to flow out from the capsule.

[0003] In the known devices, different systems are available for injecting water into the capsule. Some systems include a grid provided with multiple orifices for distributing the injected water over an upper porous membrane of the capsule, such as those described in the European Application EP 0 006 175. The injection heads can also be provided with multiple spikes, such as those described in the U.S. Pat. No. 3,607,297, for perforating a membrane closing sealingly the capsule. In some systems, the injection head includes one or several injection spikes, which are each provided with a water injection channel and which perforates the upper membrane of the capsule, in order to inject water directly inside the capsule, via the injection channels provided in the injection spikes. The injection heads provided with perforating means offer the advantage that they make it possible to provide the capsules with an upper sealing membrane, which does not need to be removed before use.

[0004] The injection systems with a single spike and in which the water injection orifice is arranged inside the capsule, have the drawback of not distributing the injected water in a uniform manner through the product contained in the capsule and this is conducive to the formation of preferential flow channels through the substance to be extracted. The result is an extraction of the product to be extracted, which is not complete and a strong decrease of the extraction pressure inside the capsule during the process, owing to the low resistance offered by the preferential flow channels.

[0005] In systems with an injection head with multiple perforating spikes, such as those described in U.S. Pat. No. 3,327,614, EP 604 615 or EP 1 203 554, the problem of preferential channels forming is decreased by comparison with the use of a single injection spike, without however being eliminated.

[0006] In all the known systems, during the extraction, the resistance to the flow of the water injected through the product contained in the capsule tends to decrease, in particular in the last phase of the extraction.

[0007] In view of the drawbacks cited above, one objective of the invention is to provide a method for preparing a beverage or a liquid foodstuff, from a capsule containing a product with a substance to be extracted, which is efficient and which makes it possible to optimise the extraction of said substance.

[0008] Another objective of the invention is to provide a device and a capsule containing a product with a substance to be extracted, for the preparation of a beverage or of a liquid foodstuff, which make it possible to optimise the extraction of said substance.

[0009] It is advantageous to provide a method for preparing a beverage or a liquid foodstuff and a device with a capsule for carrying out the method, which are capable of improving the taste and the texture of the beverage or of the liquid foodstuff obtained.

[0010] It is advantageous to provide a method and a device with a capsule for carrying out the method, in particular for the preparation of hot coffee or chocolate, which make it possible to generate a thick froth.

[0011] The objectives of the invention are achieved by a method for preparing a beverage or a liquid foodstuff according to claim **1**, through the use of a device for preparing a beverage or a liquid foodstuff according to claim **5** or claim **8**, and by a capsule containing a product with a substance to be extracted for the preparation of a beverage or a liquid foodstuff according to claim **11**.

[0012] Advantageously, the method, the device and the capsule according to the invention make it possible to ensure a good distribution of the injected water in the capsule and to retain a counter pressure within the capsule, in order to optimise the extraction of the product to be extracted, inside the capsule.

[0013] Furthermore, the method, the device and the capsule according to the invention make it possible to avoid the formation of preferential flow channels. In the case of products leaving behind spent material in the capsule, such as ground coffee, the pressure exerted by the upper membrane of the capsule against the product to be extracted, makes it possible, on the one hand, to avoid the formation of preferential flow channels and, on the other hand, to retain a counter pressure to the injection pressure, so as to ensure that the extraction proceeds during the entire extraction cycle at a high pressure, which optimises the extraction, and makes it possible to achieve a richer flavour and a more thorough extraction of the whole of the product contained in the capsule. Moreover, the high pressure applied during the entire extraction cycle makes it possible to obtain a very good froth.

[0014] The recovery of the froth can be further improved by providing, on the bottom of the capsule carrier, a collector portion with a wall defining an upwards protruding orifice provided with partial outflow slots for evacuating the liquid extract, with one portion of the froth flowing through the upwards protruding orifice of the collector portion.

[0015] In the case of products which do not leave behind any spent material, i. e. which are extracted completely, such as powdered chocolate or powdered milk, the method, the device and the capsule, according to the invention, enable an extraction which is complete while allowing for the formation of a good froth.

[0016] Other advantageous objects and features will become apparent from the claims, from the description and from the appended drawings, in which:

[0017] **FIG. 1** is a cross-sectional view of a part of a device for preparing a beverage or a liquid foodstuff, show-

ing a portion of an injection head and of a capsule carrier in which is nested a capsule filled with a product with a substance to be extracted, the injection head and the capsule carrier being in an initial position, awaiting extraction

[0018] **FIG. 2** is a view similar to **FIG. 1**, however with the injection head in its "ready for injection" position, i. e. pressed sealingly against the upper face of the capsule in the capsule carrier;

[0019] **FIG. 2*a*** is a detailed partial view illustrating the penetration, by a perforating spike of the injection head, into a flexible membrane of the capsule;

[0020] **FIG. 3** is a view similar to **FIG. 2**, in an early initial phase of the water injection;

[0021] **FIG. 4** is a view similar to **FIG. 3**, in a more advanced phase of the water injection;

[0022] **FIG. 5** is a cross-sectional view of an alternate version of the injection head and of the capsule; and

[0023] **FIG. 6** is a cross-sectional view of another alternate version of the injection head and of the capsule according to the invention.

[0024] Referring to the figures, a device for preparing a beverage or a liquid foodstuff from a capsule **1** containing a product **2** with a substance to be extracted, comprises an injection head **3** and a capsule carrier **4** which can be tightly pressed against the injection head, as illustrated in FIGS. **2** to **4**, by a bayonet system or some other system. The capsule carrier **4** has a side wall **5** and an intermediate bottom wall **6**, forming together an upper cavity portion **7*a***, into which is nested the capsule **1**. The side wall **5** has a slightly conical shape which matches the also substantially conically shape of a side wall **8** of the capsule. Advantageously, the intermediate bottom wall **6** can also be provided in the form of a filtering wall carrying a plurality of perforating spikes **9** and having outflow orifices **10** extending through said wall, wherein the spikes are designed for perforating the bottom wall **11** of the capsule.

[0025] Advantageously, the bottom wall **11** of the capsule can have a concave shape (when viewed from outside), which bulges outwards when a certain pressure is reached in the capsule during the injection, in such a manner as to make it possible for the perforating spikes **9** to perforate the bottom wall **11** and for the extracted beverage to flow out via the outflow orifices **10** of the filtering wall **6**. The liquid flows into a lower cavity portion **7*b*** of the capsule carrier located between the intermediate bottom wall **6** and a bottom wall **12**.

[0026] The bottom wall **12** of the capsule carrier **4** has an outflow channel **13** which is surrounded by a lip **14** protruding upwards with respect to the lowest point **15** of the bottom wall **12**, wherein the lip **14** includes one or several slots **16** extending to the lowest point **15** of the lower cavity portion **7*b***, in order to allow a full evacuation of the liquid from the capsule carrier. The upwards protruding lip **14** makes it possible for a portion of the froth **27** floating on the surface of the liquid **28** in the lower cavity portion to enter the evacuation channel **13** and be emptied at the same time as the liquid without froth, via the upwards protruding orifice. This system makes it possible to retain a larger amount of the froth than a conventional system in which the evacuation channel has a plain orifice at the position of the lowest point.

[0027] The capsule **1** includes a flexible membrane **17** welded or bonded to an annular flange section **18** extending radially from one end **19** of the side wall **8** of the capsule **1**. Both the flange section **18** and the welded portion of the flexible membrane **17** are held between an annular seal **20** provided on the injection head and the upper flange section **21** of the capsule carrier **4**. The side wall **8** and the bottom wall **11** of the capsule are preferable provided as a single piece made by the injection moulding of a polymer, such as polypropylene or any other plastic material capable of being recycled. The side wall **8** and the bottom wall **11** form a thin shell, which is relatively rigid by comparison with the flexible membrane **17**. The flexible membrane **17** is preferably also made from one or more polymers selected for their capacity to undergo significant elastic deformations and/or permanent deformations. Preferably, the flexible membrane is made of a material related or identical to that of the shell **8**, **11**, which advantageously facilitates the recycling of the capsule.

[0028] Advantageously, the flexible membrane **17** can be formed from a multiple layer sheet, such as a multiple layer polypropylene sheet, in order to improve its tensile strength and its deformability (elastic and/or permanent). This is important, in view of the fact that the membrane, subjected to the high pressure of the water injected during the extraction, deforms considerably. The multiple layer membrane can advantageously be formed with more than five layers. It was found that seven layers make it possible to achieve the elasticity characteristics and the tensile strength characteristics, which are optimal for specific applications.

[0029] During the extraction, the annular flange section **18** functions as a support capable of withstanding the tensile force exerted by the membrane, non only because the flange section is highly rigid in the radial direction R, but also because the flange section is pressed and retained between the capsule carrier and the annular seal **20** of the injection head.

[0030] The injection head **3** comprises a body **22** having a water supply channel **23** opening on a perforating surface **24** provided with a plurality of perforating spikes **25**, which are spaced apart from one another and distributed over the perforating surface **24**. In this embodiment, the water supply channel opens substantially at the centre of the perforating surface **24**, but it is also possible to provide several supply channels opening at different locations on the perforating surface. The diameter of the perforating surface **24** is approximately equal to or smaller than the diameter of the flexible membrane **17** of the capsule.

[0031] The perforating spikes **25** have, preferably, a conical shape, i. e. they have a cross-section, which is substantially circular. The perforating spikes could also have an elliptic cross-section or any other smooth shape (i. e. without any sharp edges), which is tapered and which ends with a perforating spike. The generator **29** of the shape of the perforating spikes is preferably a straight line, but it could also be a curved line.

[0032] Advantageously, the surface without sharp edges of the perforating spikes makes it possible to obtain a hole **26** formed through the elastic membrane **17** having an edge **26** (see **FIG. 2*a***) which is smooth, even and devoid of sharply angled portions, in order to avoid a rupture of the membrane when a tensile force is applied to the same.

[0033] The angle of the cone of the perforating spikes is, preferably, between 30 and 50°. The angle of the cone and the depth of penetration of the spike into the membrane **17** determine the diameter of the perforated hole **26**. The depth of penetration of the perforating spikes through the membrane **17** will depend, in particular, on the resistance offered by the product **2** from within the capsule, when the injection head is in its "ready for injection" lowered position, as illustrated in **FIG. 2**.

[0034] Accordingly, the elastic and permanent deformation properties of the membrane **17**, in combination with the shape of the perforating spikes (having a smooth surface and a cone with a certain angle), make it possible to form holes **26** which have a shape making the membrane resistant to tear and of which the bigger or smaller size is dependant upon the amount of the product filling the capsule and upon the compactness thereof. Accordingly, the less the capsule is filled with a product **2**, the smaller will the holes perforating the membrane be. In a situation where the product offers no counter resistance during the perforation, the diameter of the holes **26** will depend upon the shape of the perforating surface **24**, the elastic and the plastic properties of the flexible membrane **17** and upon the shape of the perforating spikes.

[0035] When water is injected under pressure via the supply channel **23**, the flexible membrane deforms under the pressure, as is illustrated in **FIG. 3**, and moves away from the perforating surface **24** of the injection head. The water under pressure flows through the flexible membrane via the plurality of perforations **26** distributed over the surface of the membrane and wets the product, which is inside the capsule. The increase in the pressure in the capsule causes the wall of the bottom **11** to bulge outwards and said wall is, accordingly, projected rapidly against the perforating spikes of the filtering wall **6** and perforated, thus enabling the liquid **28** to flow into the lower cavity portion **7***b*, as illustrated in **FIG. 4**.

[0036] The pressure exerted by the flexible membrane on the product inside the capsule during the extraction makes it possible for the product to remain relatively compact and prevents the formation of preferential flow channels. On the other hand, the pressure exerted by the membrane makes it also possible to ensure that the counter resistance to the flow of liquid through the product remains high during the entire extraction cycle, thus improving the wetting of the product, its extraction and the generation of froth.

[0037] The extent of the deformation of the flexible membrane **17** is determined by the hydraulic pressure differential ΔP between the surface **7***a* thereof onto which the water is injected and the surface **7***b* thereof facing the inside of the capsule. The pressure differential ΔP is dependent upon the size and the number of the holes **26**. The size of these holes **26** is function, amongst others, of the resistance offered by the membrane **17** to its perforation by the spikes **25**. This resistance will depend, in particular, on the amount of product **2** contained in the capsule **8**. This situation ensures an automatic adjustment of the compression of the product **2** contained in the capsule **8**. The less product there is in the capsule, the greater will the deformation of the membrane be and the lower will the flow of water be, which also restricts the formation of preferential channels.

[0038] The preferred shape of the perforating surface **24** is a convex one, as illustrated in **FIG. 6**, to engage with a flexible membrane **17** of the capsule, which is substantially planar. The curvature of the perforating surface **24**, **24'**, **24"** can be more or less pronounced and, in the case of the perforating surface **24"** having a strong curvature, the flexible membrane could even be concave (when viewed from outside), such as indicated by the reference number **17'**. The injection heads with perforating surfaces **24"** with a strong curvature can be very useful, when the capsule **1** is filled with a small amount of product, as the case may arise with tea.

[0039] The perforating surface can also have a shape which is concave (when viewed from outside) **24'"**, in the case where the capsules are filled entirely and the flexible membrane **17"** has a convex shape (when viewed from outside). In this case, the flexible membrane **17"** itself can even be semi-rigid and shaped by thermoforming, owing to the fact that it is not subjected to a tensile deformation in an initial phase of extraction or exhibit no rigidity at all, if the compressed spent material remaining in the capsule has a volume greater than the volume defined by the shell of the capsule and the membrane in the "concave" position (symmetrical with respect to the "convex" position).

1. A method for preparing a beverage or a liquid foodstuff from a capsule containing a product with a substance to be extracted, the capsule having a flexible membrane capable of significant elastic or permanent deformation, comprising the steps of perforating a plurality of holes distributed over the flexible membrane and of injecting water onto the flexible membrane in such a manner that the same deforms in the direction of the product contained inside the capsule and the water penetrates into the capsule via said holes, wherein the size of the holes perforated by the perforating spikes is controlled by the level to which the capsule is filled or by the compactness of the product inside the capsule, so as to influence the hydraulic pressure differential ΔP between opposite sides of the flexible membrane to obtain an automatic adjustment of the compression of the product contained in the capsule.

2. A method according to claim 1, wherein the flexible membrane is perforated by means of an injection head including a perforating surface provided with a plurality of perforating spikes distributed over the perforating surface and, at least one water supply channel, the perforating spikes having a tapered and smooth shape without sharp edges.

3. A method according to claim 1, wherein the flexible membrane of the capsule has a shape which is substantially planar and wherein the perforating surface of the injection head has a shape which is convex, when viewed from outside this perforating surface, urging the flexible membrane against the product inside the capsule or applying a tensile force to the membrane.

4. A method for preparing a beverage or a liquid foodstuff from a capsule containing a product with a substance to be extracted, the capsule comprising a substantially stiff container and a flexible membrane closing an open side of the container, the membrane being capable of significant elastic or permanent deformation, the method including the steps of

perforating a plurality of smooth holes distributed over the flexible membrane and

injecting water onto the flexible membrane in such a manner that the membrane deforms in the direction of

the product contained inside the capsule and in that the water penetrates into the capsule via the smooth holes without them tearing.

5. A method according to claim 4, wherein the flexible membrane is perforated by means of an injection head including a perforating surface provided with a plurality of perforating spikes distributed over the perforating surface and, at least one water supply channel, the perforating spikes having a tapered and smooth shape without sharp edges.

6. A method according to claim 4, wherein the flexible membrane of the capsule has a shape which is substantially planar and wherein the perforating surface of the injection head has a shape which is convex, when viewed from outside this perforating surface, urging the flexible membrane against the product inside the capsule or applying a tensile force to the membrane.

7. A method according to claim 4, wherein the size of the holes perforated by the perforating spikes is controlled, inter alia, by the level to which the capsule is filled or by the compactness of the product inside the capsule, so as to influence the hydraulic pressure differential ΔP between opposite sides of the flexible membrane in such a manner as to obtain an automatic adjustment of compression of the product contained in the capsule.

8. A device for preparing a beverage or a liquid foodstuff from a capsule containing a product with a substance to be extracted, wherein the device includes an injection head comprising a perforating surface having a shape which is substantially curved and convex, when viewed from outside, provided with a plurality of perforating spikes distributed over the perforating surface and at least one water supply channel arranged to supply water onto the perforating surface, the perforating spikes having a smooth tapered shape without sharp edges and an average cone angle less than 60°.

9. A device according to claim 8, wherein the perforating spikes have substantially the shape of cones with substantially straight line generators.

10. A device according to claim 8, including a body or a capsule carrier comprising a bottom wall, an intermediate bottom wall in the form of a filtering wall having a plurality of perforating spikes and outflow orifices, and a lower cavity portion arranged between the filtering wall and the bottom wall wherein the bottom wall comprises an outflow channel surrounded by lips which protrude upwards with respect to a lowest point of the lower cavity portion.

11. A device for preparing a beverage or a liquid foodstuff, comprising a body or a capsule carrier comprising a bottom wall, an intermediate bottom wall in the form of a filtering wall having a plurality of perforating spikes and outflow orifices, and a lower cavity portion arranged between the filtering wall and the bottom wall wherein the bottom wall comprises an outflow channel surrounded by lips which protrude upwards with respect to a lowest point of the lower cavity portion.

12. A device according to claim 10, wherein the upwards protruding lips have openings in the form of slots or of holes enabling liquid to flow out from the capsule carrier at the lowest point.

13. A capsule for the preparation of a beverage or of a liquid foodstuff containing a product with a substance to be extracted, wherein the capsule comprises a shell which is substantially rigid and which comprises a side wall and a bottom wall to form a container in which the product is contained, the shell further comprising an annular flange section extending substantially in a radial plane R, the capsule further comprising a flexible membrane bonded or welded to the annular flange section, the membrane and the shell being made from one or several polymers and the flexible membrane being made from a multiple layer sheet.

14. A capsule according to claim 13, wherein the shell and the membrane comprise polypropylene.

15. A capsule according to claim 13, wherein the flexible membrane is made from a sheet comprised of at least five layers.

16. A capsule according to claim 13, wherein the flexible membrane has a shape, which is substantially planar, before use of the capsule.

17. A capsule according to claim 13, wherein the side wall of the shell of the capsule is substantially conical, whereby the diameter of the cone decreases from the annular flange section in the direction of the bottom wall.

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